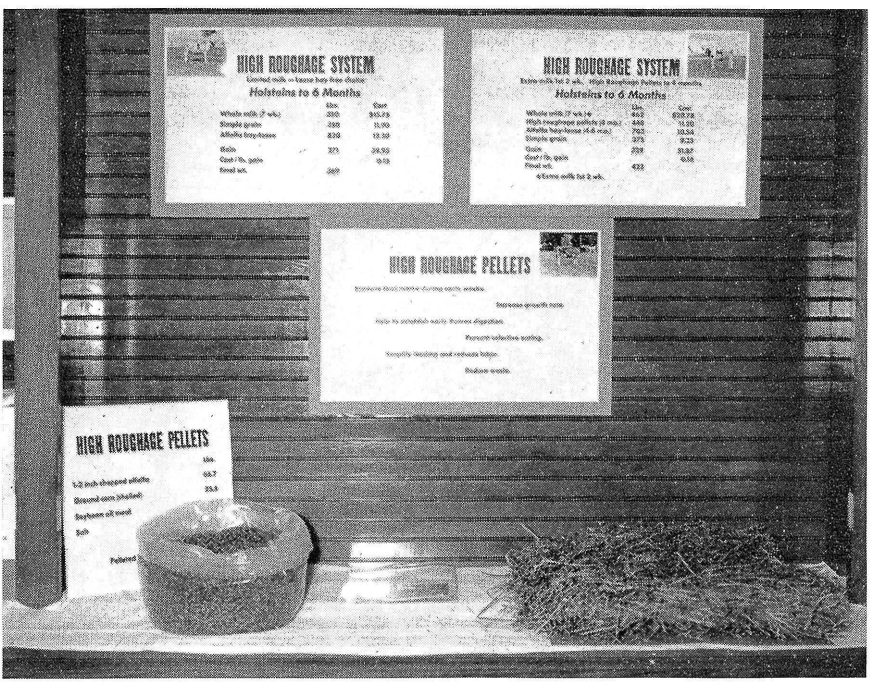
RESEARCH BULLETIN 918 JULY 1962

APPLICATION of the OHIO HIGH-ROUGHAGE CALF-RAISING SYSTEM

through a cooperative field demonstration

R. A. PORTERFIELD - J. W. HIBBS - H. R. CONRAD



OHIO AGRICULTURAL EXPERIMENT STATION
Wooster, Ohio

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APPLICATION of the OHIO HIGH-ROUGHAGE CALF-RAISING SYSTEM through a COOPERATIVE FIELD DEMONSTRATION

R. A. PORTERFIELD[1], J. W. HIBBS, and H. R. CONRAD

GENERAL SUMMARY

Eighty-nine calves in 19 herds from seven Ohio counties were used in a study of the application of the Ohio high-roughage calf-raising system under practical farm conditions.

Growth performance by breeds in this study was compared with the performance of control calves, with calves on other high-roughage feeding experiments, and with the Ragsdale, Beltsville and Cornell growth standards. The average daily rate of gain from birth through 26 weeks of age for calves in this study was 1.41 pounds for Ayrshires; 1.75 pounds for Brown Swiss; 1.51 pounds for Guernseys; 1.74 pounds for Holsteins; and 1.15 pounds for Jersey calves.

Economy of gain for calves in this study was in close agreement with the results of previous experiments. The estimated average cost per pound of gain from birth through 26 weeks of age for calves of each breed using current feed costs was 16.4 cents for Ayrshires; 16.0 cents for Brown Swiss; 14.8 cents for Guernseys; 16.3 cents for Holsteins; and 16.5 cents for Jerseys.

Sixteen of the 19 dairymen cooperating in the field demonstrations indicated that this system of calf-raising should be recommended to Ohio dairymen. Seventeen indicated that the calves raised on the high-roughage system measured up to expectations and that they liked this system as well or better than the one they are now using.

Four of the eight county extension agents in agriculture indicated that this system of calf-raising should be recommended to Ohio dairymen, two offered no opinion and two indicated that, with some modification of the system, it should be recommended.

This study has demonstrated that the high-roughage system of calf-raising using high-roughage pellets during the first eight weeks and extra milk the first two weeks can be successfully and economically applied under practical farm conditions.

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INTRODUCTION

Research in calf nutrition at the Ohio Agricultural Experiment Station in recent years has been based on a study of factors involved in the development of early rumen (paunch) function (2, 5, 9, 17, 18, 19, 20, 21, 22). This has resulted in a high-roughage, low-cost system of raising dairy calves (3, 4, 6, 10, 11, 12, 13, 14, 15).

In general, this system involves limited milk feeding for about seven weeks, free choice feeding of good quality, mostly legume hay after three days of age and the use of a simple grain mixture limited to about one-half the amout of hay being consumed. The high-roughage system encourages the early development of rumen function, including both capacity for adequate hay consumption and the microorganisms needed for its digestion. In this system the requirements for high quality protein and vitamins of the B complex are provided by the synthetic processes of the rumen microorganisms. This eliminates the need for complex, high cost calf starters. Thus the economy of the high roughage system is based on (1) consumption and digestion of large amounts of good quality roughage, which is made possible through early rumen development and (2) the use of a simple, low-cost grain mixture fed in limited amounts.

Raising herd replacements constitutes one of the major items of expense on the dairy farm. Thus, the high-roughage approach to calf-raising fits well into an economy that demands greatest efficiency in production and into the current trend toward high quality roughage production and utilization.

It was thought that this method of calf raising should be further tested under normal farm conditions, as an aid to extension workers in developing sound recommendations concerning its application.

With this objective in mind, a cooperative field demonstration was organized involving research and extension workers and cooperating dairymen, to determine if the high-roughage system of raising dairy calves could be successfully applied under farm conditions. Through first-hand observations both experiment station and extension workers were to be provided the opportunity to become familiar with management problems involved, acceptance of the system by dairymen, health problems, and the suitability of the roughage available on farms plus other problems that might arise in connection with the application of this system under farm conditions.

It was reasoned that through this approach research personnel would have an opportunity to detect any unforseen problems encoun-

tered under farm conditions which might indicate the need for further research and also be given an opportunity to apply their experience and background to the initiation and maintenance of the demonstration.

The extension personnel would have the opportunity to carry on a demonstration in the county which could be used as a tool for teaching and also enable them to make observations, in connection with frequent visits, which would help in evaluating the acceptance and practicability of the system.

The cooperating dairymen were thus provided help in trying out the system and were asked to follow directions provided and to record information which would help in the evaluation of the system.

PROCEDURE

The high-roughage feeding procedures used in this demonstration included the following features: (1) Limited whole milk feeding to seven weeks with extra milk during the first two weeks (14, 15); (2) free-choice high-roughage pellet feeding (two parts hay-one part simple grain mix) to eight-nine weeks; (3) loose hay beginning at six weeks, free choice; (4) grain feeding according to a feeding schedule provided to approximate a 2:1 hay to grain ratio after eight weeks; (5) no cud inoculations on the basis that performance was not enhanced by inoculations in previous experiments (1, 2, 7, 8, 15, 16).

COUNTIES AND HERDS

Two leading dairy counties were selected for the high-roughage field demonstration in each of Ohio's four extension supervisory districts. These selections were made by the extension dairymen in their respective districts. Cooperator-herds were selected by the county agricultural extension agent in each county. Prerequisites were that herd owners would have from four to eight heifer calves, born within a one-year period, and that they be willing to record information requested that would be of value in helping to evaluate the system. A total of 30 herds in the 8 counties were originally selected for the demonstration. Table 1 contains a list of counties, herds by county, and number of calves by breeds included in this study.

RECOMMENDED FEEDING PROCEDURE FOR THE DEMONSTRATION

Milk

Milk to be fed to calves until seven weeks of age with extra milk being recommended for the first two weeks (14, 15). Calves received colostrum milk for the first three days. The recommended whole milk

feeding schedule (extra milk first two weeks) for calves of the small, medium and large breeds are shown in Table 2.

Pellets

Six tons of high-roughage pellets (7, 15) were prepared, and delivered gratis by the McMillen Feed Mills of Decatur, Indiana, to local dealers in each of the eight counties. Pellets were packaged in 50-pound paper bags for ease of handling. Dairymen received their pellets during May 1957.

Table 1.—Counties Involved in the Ohio High-Roughage Field Demonstration

1. Champaign
*2. Fairfield
3. Licking
4. Lorain
5. Medina
6. Miami
7. Sandusky
8. Seneca

*Three calves, none raised according to high-roughage system

Herds by County and Number of Calves by Breeds High-Roughage Field Demonstration

Herd	County	Number calves	Breed
R	Champaign	4	Brown Swiss
T	Champaign	3	Holstein
U	Champaign	5	Guernsey
B	Licking	5	Jersey
C	Licking	5	Jersey
D	Licking	7	Jersey
V	Lorain	3	Holstein
W	Lorain	5	Holstein
F	Medina	5	Holstein
H	Miami	3	Holstein
I	Miami	4	Holstein
J	Miami	3*	Jersey and Holstein
K	Sandusky	6	Holstein
L	Sandusky	5	Guernsey
M	Sandusky	5	Holstein
N	Seneca	6	Holstein
O	Seneca	5	Ayrshire
P	Seneca	6	Jersey
Q	Seneca	2	Holstein

*One Holstein, two Jerseys

All pellets were ¼ inch in diameter and were prepared according to the following formula:

	Percent
½ inch Ground Alfalfa (15 percent protein)	66.7
Ground Shelled Corn (9 percent protein)	26.7
Soybean Oil Meal (44 percent protein)	6.3
Salt	0.3
	100.0

(Enough dry vitamin A concentrate was added to provide 5,000 units per pound of pellets).

Pellets were fed free choice to eight weeks of age and gradually reduced to zero during the ninth week of age.

Hay and Grain

Dairymen were urged to feed free choice, good quality, palatable hay, mostly legume, after calves were six weeks of age.

Grain feeding after eight weeks was carried out according to the schedule shown in Table 3, which provided for an approximate 2:1 hay to grain ratio with a four-pound-per-day grain limit for Holsteins and a three-pound-per-day limit for Jerseys.

Table 2.—Whole Milk Feeding Schedule

Age	(Weeks)	Large Breeds[1] pounds/feeding		Medium Breeds[1] pounds/feeding		Small Breeds[1] pounds/feeding	
		A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
1	(0-3 days)	Nurse	Dam	Nurse	Dam	Nurse	Dam
1	(4-7 days)	8	8	7	7	5	5
2		6	6	5	5	4	4
3		5	5	4	4	3	3
4		5	5	4	4	3	3
5		4	4	3	3	3	3
6		3	3	2	2	2	2
7		2	2	1	1	1	1

Milk feeding should be reduced if diarrhea occurs.

If calves are slow in starting to eat dry feed, milk feeding may be extended beyond seven weeks.

In practice milk replacer can be substituted for whole milk after the second week.

[1]Large breeds, Holstein and Brown Swiss; Medium Breeds, Ayrshire and Guernsey; Small Breeds, Jersey

Table 3.—Grain Feeding Schedule

Age (Weeks)	Large Breeds[1] pounds/feeding		Medium Breeds[1] pounds/feeding		Small Breeds[1] pounds/feeding	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
9	0.5	0.5	0.4	0.4	0.3	0.3
10	0.8	0.8	0.7	0.7	0.6	0.6
11-12	1.0	1.0	0.9	0.9	0.8	0.8
13-14	1.3	1.3	1.1	1.1	1.0	1.0
15-16	1.5	1.5	1.3	1.3	1.2	1.2
17-18	1.8	1.8	1.6	1.6	1.4	1.4
19-20	2.0	2.0	1.8	1.8	1.5	1.5
21-22	2.0	2.0	1.8	1.8	1.5	1.5
23-24	2.0	2.0	1.8	1.8	1.5	1.5
25-26	2.0	2.0	1.8	1.8	1.5	1.5

Suggested grain mix (15 percent protein):

Corn (shelled)	500 pounds
Oats (ground)	355 pounds
Soybean oil meal	125 pounds
Salt	10 pounds
Steamed Bone Meal	10 pounds

[1]Large breeds, Holstein and Brown Swiss; Medium Breeds, Ayrshire and Guernsey; Small Breeds, Jersey

INITIATION OF TRIALS

J. W. Hibbs and H. R. Conrad, together with the district extension dairyman and the county extension agent in each county, visited cooperating dairymen in January and February 1957. At this time dairymen were furnished with information regarding the various features of the high-roughage system of calf-raising and given instruction on the recordkeeping phase of it.

Barn cards were provided for each calf on which to record the following information: identification; birth date; tape weights at birth, seven weeks, sixteen weeks, and 26 weeks of age; a feeding schedule to six months of age; a space to record sickness or any abnormality; and an evaluation of the thriftiness and condition of the calf at the time of each tape measurement.

A sample barn card used for collection of data is shown in Figure 1. The grain feeding schedule was inserted for each calf prior to the start of the demonstration.

Fig. 1.—Sample barn card for recording data.

CALF No. OR NAME **OWNER**

BREED **Holstein** **BIRTH DATE**

Date	Week of Age	Milk		Pellets	Grain		Hay	Remarks
		A.M.	P.M.		A.M.	P.M.		
	1 (0-3 day)	Nurse dam		Free choice				Measure
	1 (4-7 day)	8.0	8.0	to 8 weeks				
	2	6.0	6.0					
	3	5.0	5.0					
	4	5.0	5.0					
	5	5.0	5.0					
	6	5.0	5.0					
	7	2.5	2.5				Free choice	Measure and Evaluate*
	8	0	0				hay after 6 weeks	
	9	0	0	Reduce ½	0.5	0.5		
	10	0	0	Off pellets	0.8	0.8		
	11-12	0	0	at 9 weeks	1.0	1.0		
	13-14	0	0		1.3	1.3		
	15-16	0	0		1.5	1.5		Measure and Evaluate*
	17-18	0	0		1.8	1.8		
	19-20	0	0		1.9	1.9		
	21-22	0	0		2.0	2.0		
	23-24	0	0		2.0	2.0		
	25-26	0	0		2.0	2.0		Measure and Evaluate*

*Evaluate physical condition as excellent, good or poor.

At the time of the first visit, the cooperating dairymen were all requested to sign the following menmorandum of agreement:

AGREEMENT BETWEEN THE OHIO AGRICULTURAL EXPERIMENT STATION, THE AGRICULTURAL EXTENSION SERVICE AND COOPERATING DAIRYMEN

This agreement is for the purpose of carrying out a field trial designed to test the Ohio high-roughage system of calf feeding under actual farm conditions through the cooperation of the Ohio Agricultural Experiment Station, the Agricultural Extension Service and Cooperating Dairymen in eight Ohio counties. The cooperation will be governed by the following provisions:

1. Ohio Agricultural Experiment Station Personnel will provide directions for feeding, will prescribe the formulation of the pellets to be used, and will designate the location at which they will be available. They will counsel with the extension personnel and cooperating dairymen involved regarding procedure and evaluation of results.

2. Agricultural Extension Service personnel will contact the cooperating dairymen, help in working out procedure to be followed on individual farms and in the evaluation of the results.

3. The cooperating dairyman whose signature appears below agrees to follow the directions provided, to keep such records as shall be agreed upon and to supply this information solely to the Agricultural Experiment Station and/or the Agricultural Extension Service. The Cooperator agrees further that he will not hold the Ohio Agricultural Experiment Station, the Agricultural Extension Service or the Manufacturer of the high-roughage pellets liable in any way, for any thing that may happen to the animals on his farm during or following the experimental period.

Ohio Agricultural Experiment Station	Date
Agricultural Extension Service	Date
Cooperating Dairyman	Date

RATING OF DAIRYMEN

At the beginning of the trials all dairymen were rated either excellent, good or fair by Hibbs and Conrad. The first rating was based upon (a) condition of calves and other dairy animals on the farm, (b) attitude of dairyman, and (c) environment, which included a general impression of the complete dairy setup. A second rating was recorded as a result of interviews and observations made during the final visit. The second rating was based upon (a) attitude of dairyman, (b) condition of calves raised on high--roughage system, and (c) how well the dairyman had followed the system.

COLLECTION OF DATA

Some of the barn data cards were collected in January and February 1958, during the time of the final visit by extension and research personnel. Those not complete at this time were collected by county extension agents in agriculture and mailed either to the extension dairyman or to J. W. Hibbs at Wooster.

SURVEY OF COUNTY EXTENSION AGENTS IN AGRICULTURE

To gain additional information on the Ohio high-roughage field demonstration from county extension agents in agriculture, in January 1959, the ten-question survey form shown in Figure 2 was sent to agents in the eight counties. Response to the questionnaire was 100 percent.

Fig. 2.—Questionnaire 1, Survey on High-Roughage Field Demonstration, County Extension Agents, Agriculture.

1. In your opinion were the high-roughage field trials worthwhile demonstrations in your county? _____ (Yes) _____ (No) (Check one)

2. In general were the dairymen in your county pleased with the system? _____ (Yes) _____ (No) (Check one)

3. Do you feel that this system of calf-raising should be recommended to Ohio dairymen? _____ (Yes) _____ (No) (Check one) If answer is no, please explain_____

4. Have dairymen in your county other than the field trial cooperators shown an interest in the system? _____ (Yes) _____ (No) (Check one)

5. Do you feel the procedure used in setting up the trials was a good one? _____ (Yes) _____ (No) (Check one) If answer is no, please explain_____

6. Would there be any merit in repeating similar calf feeding trials in your county? _____ (Yes) _____ (No) (Check one) If answer is yes, how many dairymen would be interested?_____

7. Is there opportunity for extension and research personnel to work together in a similar manner in other dairy areas? _____ (Yes) _____ (No) (Check one) If answer is yes, please list:

a) _____

b) _____

c) _____

8. If trials were repeated would dairymen be willing to purchase pellets at cost? _____ (Yes) _____ (No) (Check one)

9. If you feel the dairymen of Ohio should be encouraged to use this system, please list suggestions for bringing about its adoption.
a) _____
b) _____
c) _____

10. Was resistance to increasing the amount of whole milk fed calves the first two weeks nonexistent ____ great ____ very little ____? (Check one)

SURVEY OF DAIRYMEN COOPERATING IN FIELD TRIALS

A 16-question survey form was sent in January 1959, to dairymen cooperating in the high-roughage field trials. The objectives were (a) to gain added information on their general reaction to the system, (b) to determine if they are continuing to use it with either pellets or loose hay, (c) to obtain their thinking on specific likes and dislikes of the system and (d) to get their opinion on whether or not this system should be recommended to Ohio dairymen. Twenty dairymen responded to the questionnaire shown in Figure 3.

Fig. 3.—Questionnaire II. Survey of Dairymen Cooperators in High-Roughage Calf-Raising Field Demonstration.

1. Did you follow the system completely? ____ (Yes) ____ (No) (Check one)
If answer is no, please indicate changes made_____
_____
_____

2. Were you satisfied with the system? ____ (Yes) ____ (No) If answer is no, explain_____
_____
_____

3. Did you like this system better ____ as good ____ not as good ____ as the one you have been using? (Check one)

4. Did you increase the amount of whole milk fed during first two weeks? ____ (Yes) ____ (No) (Check one) If answer is yes, did you feel your calves got off to a better start? ____ (Yes) ____ (No) (Check one) Did you have a scour problem? ____ (Yes) ____ (No) (Check one)

5. Have you continued to use this system with other calves? ____ (Yes) ____ (No) (Check one) If so, where did you purchase the pellets?_____
What is the cost of the pellets?_____per cwt.

6. Would you like to continue using this system if you could purchase pellets at a reasonable cost? ____ (Yes) ____ (No) (Check one)

7. Have any of your neighbors tried this system? ____ ____ (Check one)
Yes No

8. How many calves do you raise each year? _____

9. Do you think this system should be recommended to Ohio dairymen? ____ ____ (Check one)
Yes No

10. Did calves raised on this system measure up to expectations in size and condition at six months of age? ____ ____ (Check one) If answer is no, explain_____
Yes No

_____

11. Did you have any death losses while using this system? ____ (Check one) If answer is yes, how many? ____ Do you think it was the fault of the system? ____ ____ (Check one)
Yes No Yes No

12. Are high-roughage calves larger ____ smaller ____ about same size ____ as other calves the same age? (Check one)

13. Are high-roughage calves in better condition ____ poorer condition ____ about the same condition ____ as other calves the same age? (Check one)

14. What did you like about the system?

a) _____
b) _____
c) _____

15. What were the main drawbacks?

a) _____
b) _____
c) _____

16. Have you continued using this system with loose hay instead of pellets? ____ ____ (Check one) If answer is yes, have your results been satisfactory ____ unsatisfactory____? (Check one)
Yes No

SUPERVISION

The initial and final visits by county extension, dairy extension and research personnel plus several interim visits and letters constituted the method of supervision of the field demonstration.

RESULTS AND DISCUSSION

Ten years of experimental work on the high-roughage system of raising dairy calves by workers at the Ohio Agricultural Experiment Station had indicated that this system could be successfully applied under farm conditions.

Of the 30 Ohio dairymen in 8 counties who originally signed a memorandum of agreement with the Ohio Agricultural Experiment

Station and the Ohio Agricultural Extension Service to cooperate in the field demonstration, 19 submitted sufficiently complete data on 89 calves for this study. Data on calves from two herds were lost, one herd was dispersed, cards from one herd contained insufficient data, two herds cancelled their agreement, and the remaining herd owners either didn't follow the system or failed to submit data.

Complete data were obtained on a total of 43 Holsteins, 20 Jerseys, 10 Guernseys, 12 Ayrshires and four Brown Swiss calves in the 19 herds.

FEEDING

Eleven herd owners indicated that they fed extra milk to calves during the first two weeks as recommended. Eight herd owners altered the amount of milk fed during this period either because of a diarrhea problem or because some calves refused the full amount offered. To compensate for reduced milk feeding during the first two weeks, some of the herd owners either fed additional milk during the remainder of seven-week milk feeding period or extended the period to eight weeks.

In herd W, calves received 17 pounds less milk than was recommended for the seven-week period, whereas, in herd U, calves exceeded the recommended amount by an average of 38 pounds per calf. These differences were not considered to be significant and, therefore, calves from both of these herds were included in the study. Three control Holstein calves, raised at the Ohio Agricultural Experiment Station, were fed an average of 416 pounds of whole milk during the milk feeding period.

Grain concentrate fed from the ninth week through the 26th week to calves in 18 of the herds consisted of a simple 15 percent protein mixture. This grain ration was fed along with good alfalfa or alfalfa hay at an approximate ratio of two parts hay to one part grain. The grain limit per day for Holsteins was four pounds, for Jerseys, three pounds. Calves in herds J and U received 70 and 157 pounds less concentrate respectively than the recommended amount. In herd U, the concentrate ration was slightly higher than 15 percent protein, and calves in this herd also received an average of 38 pounds per calf more than the recommended amount of milk. Those two factors appeared to compensate for the lesser amount of grain since the growth of calves in this herd did not appear retarded.

The high-roughage pellets (15 percent protein) containing an approximate 2:1 ratio of hay to grain were fed to all calves for a period of nine weeks. Weights on pellet consumption were not available on individual calves; however, it was estimated in advance, based on pre-

vious experience, that Holstein and Brown Swiss calves would consume approximately 75 pounds, Guernsey and Ayrshire 60 to 70 pounds, and Jersey calves 50 to 60 pounds of pellets during the nine-week period. Dairymen cooperating in the program were provided with a supply of high-roughage pellets for raising at least five calves of their respective breeds based upon these estimates. Three Holstein calves, raised as controls, at the Ohio Agricultural Experiment Station consumed an average of 76 pounds of these high-roughage pellets during the nine-week period. Thus, all Holstein and Brown Swiss calves in the high-roughage field demonstration were credited with 75 pounds of high-roughage pellets each. Pellets credited to the Jersey calves averaged 50 pounds each; however, calves in herd C received slightly less than 50 pounds each while those in herd P received slightly more than this amount. All Guernsey calves were credited with 70 pounds of pellets each. Ayrshire calves in herd D were credited with 50 pounds each and those in herd 0 with 70 pounds each.

The amount of hay consumed by calves of the various breeds from six weeks through 26 weeks of age was estimated. For Holstein and Brown Swiss calves the estimate was 858 pounds, the average amount consumed by the three Holstein calves raised as controls at the Ohio Agricultural Experiment Station. Estimates on hay consumption for calves of other breeds were determined by the use of a percentage factor. To arrive at this factor, the average weight of calves of each of the other breeds at six months of age was divided by the average weight of Holstein calves at six months of age in the high-roughage field demonstration. The factor for each breed was then applied to the amount of hay consumed by Holstein calves. These estimates appear to be in line with previous work reported (15).

In computing feed costs to six months of age, feed prices were assigned as follows: Milk $4.50/100 lb.; high-roughage pellets, $3.00/100 lb.; hay, $35.00/ton; and grain, $3.80/100lb.

Dairymen who cooperated in the high-roughage field demonstration were requested to record the tape weight of calves at birth, seven, 16 and 26 weeks of age. Calves of each breed with complete data on tape weights for the various ages were used for establishing a growth curve for each breed. Growth curves based on adjusted tape weights for calves in the high-roughage field demonstration are shown in figure 4. Calves with incomplete data on tape weights for the various ages, but with two or more recorded weights, were also included in this study.

The weights of these calves for the ages not recorded were estimated by fitting known weights to the curves for the respective breeds where complete data were available.

The average tape weight for all calves at various ages by breeds and by herds was adjusted to scale weights using data taken from high-roughage fed Holstein calves raised at the North Central Substation. Tape weights were compared with scale weights and the differences determined at birth, eight, 16 and 26 weeks of age. The differences at birth, eight weeks and 16 weeks of age showed that, on the average, tape weights exceeded actual scale weights by 16.8, 19.5 and 17.3 pounds respectively. The difference at 26 weeks of age was reversed, the average tape weight at this age being 19.6 pounds less than the recorded scale weight. Holstein tape weights were adjusted to scale weight by using the above differences. Tape weights for calves of the other breeds were adjusted to scale weight by use of an adjustment factor for the various ages. This adjustment factor for each age was determined by dividing the average scale weight for Holstein calves at the North Central Substation by the tape weight and multiplying by 100. When the adjustment factor was applied to the tape weight for Jersey calves at birth, the weights appeared unusually high. For the

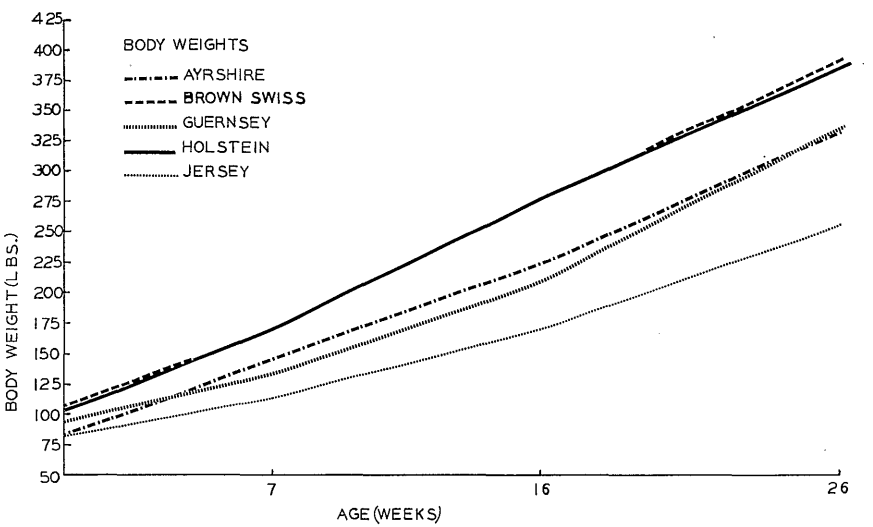

Fig. 4—Average Body Weight (unadjusted tape weights) of Calves with Complete Data on Weights for Each of the Breeds Included in the High-Roughage Field Demonstration at birth, seven, 16 and 26 Weeks of Age.

calculations, Jersey birth weights were further adjusted to the Beltsville standard (26). In all adjustments from tape to scale weight at seven weeks of age, the eighth week difference for Holsteins or the calculated eighth week factor for the other breeds was based on the Holstein (North Central Substation) data, (Table 4). Table 4 contains data used in making adjustments from tape weight to scale weight.

GROWTH OF CALVES

Adjusted growth of calves in this field demonstration was compared with control calves, calves in other high-roughage experiments and with Ragsdale (23), Beltsville (26), and Cornell (24) standards for growth. These comparisons are illustrated graphically in Figures 5, 6, 7 and 8.

It is interesting to note that, on the average, the calves of the Ayrshire, Guernsey, Holstein and Jersey breeds exceeded, without ex-

Table 4.—North Central Substation Tape Weights vs. Scale Body Weights at Various Ages (Holstein)

Calf Number	Birth		8 Weeks		16 Weeks		26 Weeks	
	Scale	Tape	Scale	Tape	Scale	Tape	Scale	Tape
	(lbs.)	(lbs.)	(lbs.)	(lbs.)	(lbs.)	(lbs.)	(lbs.)	(lbs.)
98	108	132	162	192	236	247	390	405
101	92	117	150	192	248	298	418	395
103	95	117	146	167	254	298	412	395
106	112	137	181	192	306	298	490	434
109	108	127	151	167	244	256	392	395
115	96	107	145	157	227	249	382	354
118	86	100	142	147	246	236	406	375
121	106	117						
123	100	100						
124	90	107						
Total	993	1161	1077	1214	1761	1882	2890	2753
Average (10)	99.3	116.1	153.9	173.4	251.6	268.9	412.9	393.3
Tape		116.1		173.4		268.9		393.3
Scale		99.3		153.9		251.6		412.9
		+16.8		+19.5		+17.3		—19.6
Adjustment factor		85.5		88.8		93.6		105.0

$$\frac{\text{Scale Weight}}{\text{Tape Weight}} \times 100 = \text{Adjustment factor}$$

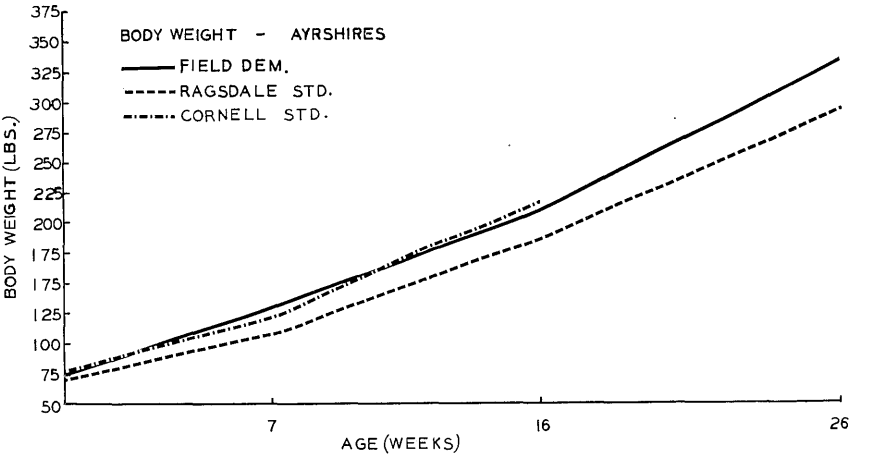

Fig. 5.—Average Adjusted Body Weight of 12 Ayrshire Calves in High-Roughage Field Demonstration at birth seven, 16 and 26 Weeks of Age Compared with Ragsdale and Cornell Growth Standards.

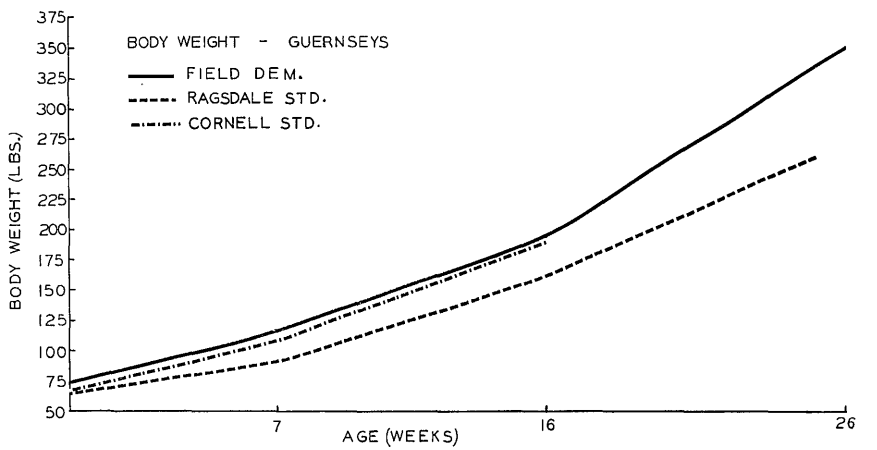

Fig. 6.—Average Adjusted Body Weight of Ten Guernsey Calves in High-Roughage Field Demonstration at birth, seven, 16 and 26 Weeks of Age Compared with Ragsdale and Cornell Growth Standards.

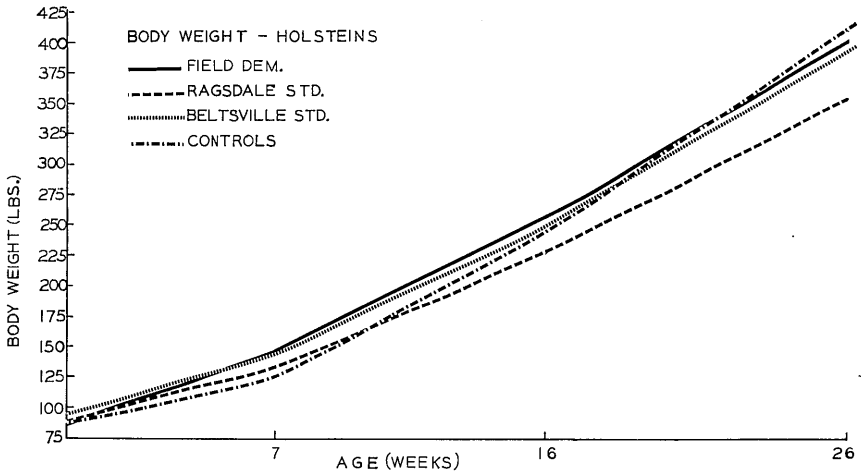

Fig. 7.—Average Adjusted Body Weight of 43 Holstein Calves in High-Roughage Field Demonstration at birth, seven, 16 and 26 Weeks of Age Compared with Ragsdale and Beltsville Growth Standards and Three Control Calves.

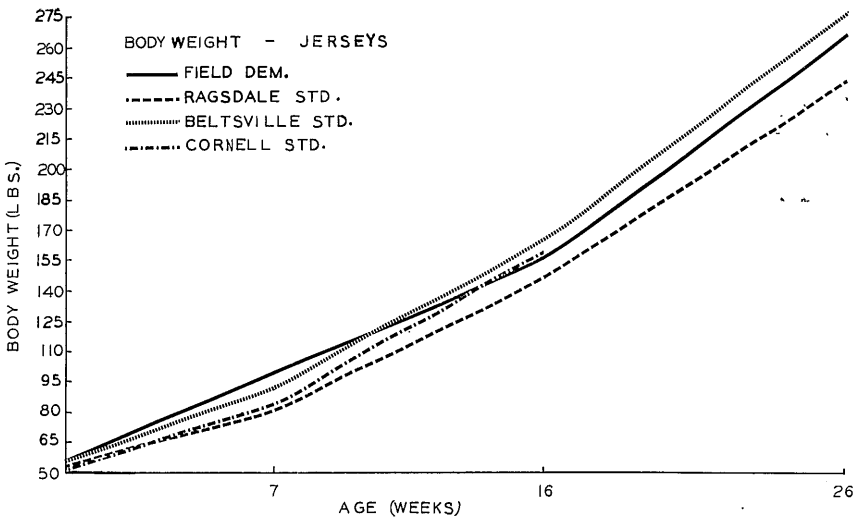

Fig. 8.—Average Adjusted Body Weight of 20 Jersey Calves in High-Roughage Field Demonstration at birth, seven, 16 and 26 Weeks of Age Compared with Ragsdale, Beltsville and Cornell Growth Standards.

ception the Ragsdale standard for body weight at seven, 16 and 26 weeks of age. To illustrate, Ayrshire calves exceeded this standard at 26 weeks of age by 40 pounds; Guernsey calves by 90 pounds; Holstein calves by 48 pounds; Jersey calves by 23 pounds at this age. When growth of calves in this study was compared to the Cornell standard for body weight at seven and 16 weeks of age, very little difference could be noted. Growth of Holstein and Jersey calves was also compared with the Beltsville standard for growth. Holstein calves at 26 weeks of age exceeded this standard by nine pounds; whereas Jersey calves, at this age, fell short of this standard by 11 pounds.

Calves of these two breeds also compared favorably in growth with other calves raised on experiment at the Ohio Agricultural Experiment Station (14, 15). Holstein calves in the field study weighed 403 pounds at 26 weeks of age. Holstein calves raised as controls weighed 411 pounds at this age. Again, the difference does not appear significant. Tables 5, 6, and 7 contain information on growth comparisons.

Since growth of calves in this study compares favorably with the various growth standards and also with controls, it may be said that daily rate of gain for calves of all breeds was in close agreement with, or exceeded, these standards. Table 8 shows that the average daily rate of gain from birth through 26 weeks of age was 1.41 pounds for Ayrshires, 1.75 for Brown Swiss, 1.51 for Guernseys, 1.74 for Holsteins, and 1.15 pounds for Jerseys. Average daily gain to six months for calves of each breed in this study are in close agreement with those set forth by Turk (25).

Table 5.—Average Body Weights of Calves by Breeds at Various Ages in High-Roughage Field Demonstration (Adjusted to Scale Weight*)

Breed	Birth	7 Weeks	16 Weeks	26 Weeks
	(lbs.)	(lbs.)	(lbs.)	(lbs.)
Ayrshire	76.0	129.0	209.0	333.0
Brown Swiss	93.0	151.0	258.0	412.0
Guernsey	75.0	116.0	193.0	350.0
Holstein	87.0	147.0	256.0	403.0
Jersey	56.0**	99.0	155.0	266.0

*Tape weights of all calves were adjusted to scale weights as discussed.

**Birth weights after adjustment appeared unusually high and were adjusted to Beltsville standard.

Table 6.—Average Adjusted Body Weights of Calves on High-Roughage Field Demonstration Compared with other Growth Standards

	Field demonstration	Ragsdale	Beltsville	Cornell
	(lbs.)	(lbs.)	(lbs.)	(lbs.)
Guernseys				
Birth	75	65		68
7 weeks	116	92		108
16 weeks	193	160		190
26 weeks	350	260		
Ayrshires				
Birth	76	72		77
7 weeks	129	107		121
16 weeks	209	185		215
26 weeks	333	293		
Jerseys				
Birth	56*	53	56	52
7 weeks	99	81	91	83
16 weeks	155	146	165	160
26 weeks	266	243	277	

*Birth weights appeared unusually high and were adjusted to Beltsville standard.

Range in average daily rate of gain from birth through 26 weeks of age for calves among 11 Holstein herds was 1.49 pounds for herd J to 2.05 pounds for herd V. The range among Jersey herds was 0.81 for herd B to 1.29 pounds for herd P. Average daily rate of gain for calves in the two Guernsey herds was 1.49 pounds for herd L and 1.53 pounds for herd U. For Ayrshire herds, the average daily rate of gain to 26 weeks was 1.70 pounds for herd D and 1.02 pounds for herd O.

Table 7.—Average Body Weights of Calves in High-Roughage Field Demonstration (Adjusted) Compared with Control Calves and Other Growth Standards (Holsteins)

	Field Demonstration	Control	North Central Substation	Ragsdale	Beltsville	Cornell
	(lbs.)	(lbs.)	(lbs.)	(lbs.)	(lbs.)	(lbs.)
Birth	87	87	99	90	96	95
7 Weeks	147	125	142	134	145	142
16 Weeks	256	245	252	227	250	258
26 Weeks	403	411	413	355	394	

Table 8.—Average Daily Rate of Gain of Calves by Breeds in High-Roughage Field Demonstration from Birth Through 7 Weeks, 8 Weeks through 16 Weeks, 17 Weeks through 26 Weeks, and Birth through 26 Weeks.

	Birth 7 Weeks Gain	8 Weeks 16 Weeks Gain	17 Weeks 26 Weeks Gain	Birth 26 Weeks Gain
	(lbs./day)	(lbs./day)	(lbs./day)	(lbs./day)
Ayrshire	1.08	1.27	1.77	1.41
Brown Swiss	1.18	1.70	2.20	1.75
Guernsey	0.84	1.22	2.24	1.51
Holstein	1.22	1.73	2.10	1.74
Jersey	0.88	0.89	1.59	1.15

FEED CONSUMPTION, COSTS AND GRAIN

The average cost of raising calves of the various breeds and individual herds to 26 weeks of age was calculated using feed amounts and prices referred to earlier. The estimated cost for raising Holstein calves in this study to 26 weeks of age was $51.14; for Ayrshire, $42.18; Brown Swiss, $51.05; Guernsey, $40.78; and for Jersey calves, $34.59.

Average gain from birth through 26 weeks of age was calculated for calves by breed and by herds within the breed. The average gain for the six-month period was 257 pounds for Ayrshire calves, 318 pounds for Brown Swiss, 275 pounds for Guernsey, 314 pounds for Holstein, and 210 pounds for Jersey calves (Beltsville standard for average birth weight used in calculating average gain in Jerseys).

By dividing the average cost by the average gain in pounds from birth through 26 weeks of age, the estimated cost per pound of gain was obtained for calves of each breed and for calves by herds within the breed. For Brown Swiss, Holstein and Ayrshire calves, the estimated cost per pound of gain for this period was approximately 16 cents. For Jerseys the estimated cost was 16.5 cents per pound, and for Guernseys, it was less than 15 cents. Table 9 contains information on the performance of calves by breeds used in this study. The total cost, total gain and cost per pound of gain of the Holstein calves in this study closely approached the Holstein calves used as controls. See Table 10 for performance of controls.

Average cost per pound of gain among the Holstein herds ranged from 13.7 cents in herd V to 17.0 cents in herds I and N. In the Jersey herds the cost per pound of gain ranged from 14.2 cents in herd J

Table 9.—Performance of Calves Fed High-Roughage Pellets in High-Roughage Field Demonstration (Pellets fed for nine weeks)

	Ayrshire	Brown Swiss	Guernsey	Holstein	Jersey
Whole milk, 7 weeks (pounds)	322	414	341	414	264
High-roughage pellets (pounds)	60	75	70	75	53
Alfalfa mixed hay (pounds)	70	858	745	858	568
Grain (pounds)	354	399	271	399	297
Cost to 6 months (dollars)	$ 42.18*	$ 51.05*	$ 40.78*	$ 51.14*	$ 34.59*
Gain (pounds)	257	318	275	314	210
Cost per pound of gain (dollars)	0.164	0.16	0.148	0.163	0.165
Final weight, 6 months (pounds)	333	412	350	403	266

*Feed costs used were: Milk, $4.50/100 pounds; high-roughage pellets, $3.00/100 pounds; hay, $35.00/ton; grain, $3.80/100 pounds.

to 23.5 cents in herd B. The average birth weight of Jersey calves by herds was not adjusted to the Beltsville standard for these calculations. It was adjusted for all Jersey calves when the average cost per pound of gain was figured for each breed. Had this adjustment been made, the extremes in the range would have been 13.0 cents for herd J and 21.5 cents for herd B. Average cost per pound of gain for Guernseys was 15.9 cents in herd L and 13.8 cents in herd U. For Ayrshires, in herd D the average cost per pound of gain was 13.6 cents, and in herd O this cost was 23.0 cents.

PERFORMANCE OF CALVES IN HERD M

Herd owner M kept complete data on five Holstein calves raised on the Ohio high-roughage system and on four Holstein calves raised on his own system. Calves on the high-roughage system made an aver-

Table 10.—Performance of Three Control Calves (OAES) High-Roughage Field Demonstration (Calves fed high-roughage pellets)

Whole milk, 7 weeks (pounds)	416
High-roughage pellets (pounds)	76
Alfalfa mixed hay (pounds)	858
Grain (pounds)	394
Cost to 6 months (dollars)	50.99*
Gain (pounds)	324
Cost per pound gain (dollars)	0.157
Final weight-6months (pounds)	411

*Feed costs used were: Milk, $4.50/100 pounds; high-roughage pellets, $3.00/100 pounds; hay, $35.00/ton; grain, $3.80/100 pounds.

age gain of 307 pounds from birth through 26 weeks of age compared to an average gain of 290 pounds for calves raised on his own system. The estimated cost per pound of gain for the high-roughage calves was 16.6 cents compared with 23.9 cents for his own system. Table 11 lists the performance of both groups of calves in herd M.

Table 11.—Performance of Calves in Herd M

	High-roughage system (5 calves)	Herd M system (4 calves)
Whole milk (pounds)	414	975
High-roughage pellets (pounds)	75	50**
Alfalfa hay (pounds)	858	858
Grain (pounds)	399	200
Cost to 6 months (dollars)	51.06*	69.27*
Gain (pounds)	307	290
Cost per pound gain (cents)	16.6	23.9
Final weight 6 months (pounds)	391	383

*Milk, $4.50/100 pounds; high-roughage pellets, $2.50/100 pounds; calf starter pellets, $5.35/100 pounds; hay, $30.00/ton; grain, $3.80/100 pounds.

**Calf starter pellets.

Performance of Jersey and Holstein calves in the high-roughage field demonstration, from the standpoint of gain from birth through six months, and cost per pound of gain when compared with Jersey and Holstein calves raised on this system at the Ohio Agricultural Experiment Station, was in close agreement. Table 12 presents the results of recent experiments at the Ohio Station (14).

Table 12.—Performance of Experiment Station Calves Fed High-Roughage Pellets for 16 Weeks (14)

	Jersey	Holstein
Whole milk, 7 weeks (pounds)	292	466
Alfalfa hay (pounds)	454	646
High-roughage pellets (pounds)	313	427
Grain (pounds)	202	272
Cost to 6 months (dollars)	33.65*	50.58*
Gain (pounds)	216	317
Cost per pound gain (dollars)	0.16	0.16
Final weight, 6 months (pounds)	262	410

*Feed costs used were: Milk, $4.50/100 pounds; high-roughage pellets, $2.50/100 pounds; hay, $30.00/ton; grain, $3.40/100 pounds.

RATING OF DAIRYMEN

The initial and final ratings of the 30 dairymen by J. W. Hibbs and H. R. Conrad are summarized in Table 13. Values of 3, 2 and 1 were assigned to the ratings, excellent, good and fair respectively. Using these values, the weighted average for the initial rating was 2.1 and for the final rating, 2.0. An increase of three in the number of dairymen with a final rating of fair can be accounted for by failure of these dairymen to cooperate fully in the high-roughage demonstration.

Table 13.—Rating of all 30 Dairymen Involved in High-Roughage Field Demonstration

Rating	Initial*		Final**	
	Number	Value***	Number	Value***
1) Excellent	8	24	10	30
2) Good	16	32	11	22
3) Fair	6	6	9	9
Total	30	62	30	61
Average Rating		2.1		2.0

*Initial ratings made at time of first farm visit.
**Final ratings based upon final visit to farm plus data submitted.
***Values assigned to excellent, good and fair are 3, 2 and 1 respectively.

Initial and final ratings of the 19 dairymen whose calves were included in this study are summarized in Table 14. The initial rating

Table 14.—Rating of 19 Dairymen Whose Calves are Included in this Study

Rating	Initial*		Final**	
	Number	Value***	Number	Value***
1) Excellent	5	15	9	27
2) Good	9	18	10	20
3) Fair	5	5	0	0
Total	19	38	19	47
Average Rating		2.0		2.5

*Initial ratings made at time of first farm visit.
**Final ratings based upon final visit to farm plus data submitted.
***Values assigned to excellent, good and fair are 3, 2 and 1 respectively.

distribution was five excellent, nine good, and five fair, for an average rating of 2.0. The final rating shows a distribution of nine excellent and ten good for an average rating of 2.5. In Table 14 there is summarized the initial and final ratings of the 19 herd owners included in this study.

In Table 13 it is shown that the average ratings for all 30 dairymen were about the same (2.1, 2.0) for both initial and final ratings. This suggests that the method of evaluation by Hibbs and Conrad was fairly accurate for the entire group. Average rating of the 19 dairymen whose calves are included in this study was also good (2.0) for the initial and very good (2.5) for the final rating. From these observations, it may be assumed that the initial evaluation by Hibbs and Conrad for this group was either too low or that these dairymen improved their calf raising procedures during the demonstration period.

PHYSICAL EVALUATION OF CALVES BY DAIRYMEN

Dairymen cooperating in the demonstration were requested to make a physical evaluation of their calves at seven, 16 and 26 weeks of age. Values of 3, 2, 1 and 0 were assigned to the ratings of excellent, good, fair and poor. The average rating at the above ages (Table 15) was 2.15, 2.03 and 2.20 respectively. The ratings indicate that calves fed extra milk during the first two weeks were in good physical condi-

Table 15.—Physical Evaluation of the Calves by Dairymen at Seven, 16 and 26 Weeks of Age

Rating	7 Weeks		16 Weeks		26 Weeks	
	Number	Value	Number	Value	Number	Value
Excellent (3)	22	66	7	21	18	54
Good (2)	60	120	79	158	71	142
Fair (1)	5	5	2	2	0	0
Poor (0)	2	0	1	0	0	0
Total	89	191	89	181	89	196
Average rating		2.15		2.03		2.20

tion at the close of the milk feeding period, or at seven weeks of age. At 16 weeks of age, the calves were rated lower than at seven weeks, but at 26 weeks of age they exceeded the rating at seven weeks. It is also interesting to note that at 26 weeks of age, 18 calves were rated excellent, 71 good and no calves received ratings of fair or poor.

SURVEY OF COOPERATING DAIRYMEN

Response of dairymen in the high-roughage field demonstrations revealed that the majority (a) were satisfied with the system, (b) thought the system should be recommended to all dairymen in Ohio, (c) said calves raised on this system measured up to expectations, (d) were continuing to use the system either with pellets or with loose hay, and (e) indicated that high-roughage calves were about the same size as calves the same age raised on their own system. Eight dairymen stated that they liked this system of calf-raising better than their own. Nine men were of the opinion that the high-roughage calves were in better condition than other calves the same age raised on their own system.

Sixteen of the 19 cooperators who had calves in this study responded to the questionnaire (Table 16). The other four responses were from dairymen who cooperated with the demonstrations but whose data were either inadquate or unavailable for this study. Fourteen dairymen said that they followed the system completely. Six dairymen answered yes to the question, "Did you increase the amount of whole milk fed during the first two weeks?". There is a discrepancy

Table 16.—What Dairy Cooperators Said About the System (Results of Survey)

		Yes	No	No Answer
1.	Followed system completely	14	6	
2.	Satisfied with system	17	3	
3.	Whole milk increased first two weeks	6	14	
4.	Scour problem	7	13	
5.	Continued using system with pellets	3	17	
6.	Continued using system with loose hay	14	6	
7.	Would continue using system if pellets were available and at a reasonable cost	14	5	1
8.	System should be recommended to Ohio dairymen	16	2	2
9.	Calves measured up to expectation	17	3	
		Better	As Good	Not as Good
10.	How dairymen liked this system compared with own system	8	9	3
		Larger	Smaller	About same Size
11.	How high-roughage calves compared with other calves same age	2	1	17
		Better	Poorer	Same Condition
12.	How condition of high-roughage calves compared with other calves same age	9	1	10

between the answer to this question and the answer to the one which asks if they followed the system completely. This may be explained in part by the fact that the question concerned with extra milk feeding was not clearly stated, and also because some dairymen may not have considered extra milk feeding during the first two weeks as a part of the system. Seven dairymen indicated some trouble with calf scours (diarrhea) while 13 experienced no trouble at all. One dairyman attributed the cause of scours and the subsequent death of one of his calves to the feeding of extra milk during the first two weeks of the calf's life. See Table 17 for additional information on the survey.

Table 17.—Questionnaire Concerning Application of High-Roughage System (Response to the question, "What did you like about the system?")

1.	Calves consume more roughage at an early age.
2.	Has greater economy.
3.	Calves develop more body at an early age.
4.	Pellets easy to handle and simplifies the feeding of hay and grain.
5.	Reduces problem of calf scours.
6.	Calves get off to a better start.
7.	Calves don't get so fat.
8.	Calves do better in the early growing period.
9.	Calves not overfed on grain.
10.	Took less total milk than own system.

Dairy cooperators were asked to enumerate both advantages and disadvantages of the system based primarily upon personal experience gained through participation in the demonstrations. High on the list of advantages were such things as: Greater economy; higher consumption of roughage at an early age; and simplified hay and grain feeding through the use of pellets during the first few weeks.

Listed as the main disadvantages were: (1) Calves are slow to start eating pellets; (2) amount of milk recommended for the first week is too high; and (3) cost of pellets is high and their availability is limited. Tables 17 and 18 list the advantages and disadvantages attributed to the system. It is interesting to note that some dairymen credit the system with reducing the problem of calf scours while others credit extra milk fed during the first week or two as a cause of calf scours and, therefore, were inclined to place the blame on the system. It seems only logical to conclude that some dairymen do not fully appreciate the need for feeding extra whole milk during the first two weeks in a calf's life.

Table 18.—Questionnaire Concerning Application of High-Roughage System (Response to the question. "What were the main disadvantages to the system?")

1. Too much milk the first week.
2. Calves slow to start eating pellets.
3. Availability of pellets limited and cost of pellets is high, ($3.00/100 pounds).
4. High milk causes scouring.
5. Takes extra time to get calves to eat pellets.

SURVEY COUNTY EXTENSION AGENTS IN AGRICULTURE

In general, county extension agents in agriculture indicated (Table 19) the high-roughage field demonstrations were worthwhile; that the procedure for setting them up was a good one, and that dairy extension and dairy research personnel could be of additional assistance to Ohio dairymen by working together on other dairy problems using the same or a similar approach. It was suggested by one agent that closer follow-up on the demonstration and an earlier summary of the results would have been of value not only to the cooperators themselves, but to other dairymen considering the use of this system.

Agents in five counties indicated that dairymen were pleased with the system; those in two counties stated that dairymen were not pleased, and one agent gave no opinion Responses of agents from four counties

Table 19.—Response of Eight County Extension Agents, Agriculture, to the High-Roughage Field Demonstration

	Yes	No	Other
Field demonstrations were worthwhile.	7	1	
Dairymen of county were pleased with system.	5	2	1
Dairymen other than field demonstration cooperators have shown interest in system.	4	4	
Procedure for setting up trials was good one.	7	1	
There would be merit in repeating the trials.	5	2	1
Extension and Research should work together in other dairy areas.	7		1
If trials were repeated, dairymen would be willing to purchase pellets.	5	2	1
High-roughage system of calf-raising should be recommended to Ohio dairymen.	4	2*	2
	Non-existent	Great	Very Little
Resistance to extra milk feeding first two weeks was	2	2	4

*Yes, with certain modifications.

indicated that dairymen other than cooperators in the field demonstration expressed interest in the high-roughage system of calf-raising.

Four agents favored recommending this system of calf-raising to Ohio dairymen, two opposed it, and two expressed no opinion at all.

Agents who indicated that the system should be recommended to Ohio dairymen suggested a number of ways of acquainting herd owners with it (Table 20). High among the suggestions was the publication of simple directions for its use, plus cost data for this system versus other systems, and results of recent field demonstrations. Conducting similar demonstrations in other counties, continued educational efforts through extension teaching and further modification of the system such as wetting the hay and grain mixture (2:1) instead of pelleting were other suggestions made by this group.

Table 20.—Suggested Ways and Means for Encouraging Ohio Dairymen to Adopt the Ohio High-Roughage System of Calf-Raising

1. Publication (bulletin, pamphlet, leaflet) giving:
   a) Simple directions for using system.
   b) Cost figures for system vs. other systems.
   c) Results of field demonstration.
2. Demonstrations in other counties and testimonials of demonstrators.
3. Dairy specialists continue to educate dairymen in use of system.
4. Acquaint dairy service unit boards, DHIA supervisors, and artificial breeding technicians with the merits of the system.
5. Radio, press and television.
6. Feeding chopped hay and grain mixture (2:1 hay to grain ratio) by wetting instead of pelleting.

SUMMARY AND CONCLUSIONS

A field demonstration on the high-roughage calf-raising system was carried out in 19 herds in seven Ohio counties. Data have been presented and summarized on 43 Holstein, 20 Jersey, 12 Ayrshire, 10 Guernsey and four Brown Swiss calves. The main objective of this study was to determine if this system of calf-raising could be successfully applied under practical farm conditions.

Growth performance by breeds of calves in the high-roughage field demonstration was in agreement with, or exceeded, performance of calves in other high-roughage experiments. The calves also compared favorably with Beltsville, Ragsdale and Cornell growth standards. The average daily rate of gain from birth through 26 weeks of age for calves, by breed, in this study was 1.41 pounds for Ayrshires; 1.75

pounds for Brown Swiss; 1.51 pounds for Guernseys; 1.74 pounds for Holsteins; and 1.15 pounds for Jersey calves.

Economy of gain for calves in this study was in close agreement with the results of previous work at the Ohio Agricultural Experiment Station. The average cost per pound of gain from birth through 26 weeks of age for calves of each breed in this study was 16.4 cents for Ayrshires; 16.0 cents for Brown Swiss; 14.8 cents for Guernseys; 16.3 cents for Holsteins; and 16.5 cents for Jerseys.

Sixteen of twenty dairymen cooperating in the field demonstration indicated that this system of calf raising should be recommended to all dairymen in Ohio, two were opposed and two dairymen gave no opinion. Seventeen of the twenty dairymen indicated that they were pleased with the system, that calves measured up to their expectations and that they liked this system as good or better than the one they are now using. This same number of dairymen stated that they are continuing to use the high-roughage system by feeding either loose hay or pellets.

Of the eight county extension agents in agriculture, seven stated that the field demonstration was worthwile and that the procedure for setting it up was a good one. Five agents stated that the cooperating dairymen in their respective counties were pleased with the system, two stated they were not, and one gave no opinion. Four of the eight agents indicated that this system of calf-raising should be recommended to Ohio dairymen, two offered no opinion and two indicated that with some modification of the system, it should be recommended although they answered no to the query.

The nineteen dairymen whose calves were included in this study were given an average rating of good (2.0) at the time the demonstration was initiated and an average rating of very good (2.5) at the conclusion.

Demonstration calves were evaluated on the basis of physical condition by cooperating dairymen at seven, 16 and 26 weeks of age. The weighted average for ratings at these ages was 2.15, 2.03 and 2.20 respectively.

Under the conditions of this study, evaluation of the data indicate the following:

a) That the high-roughage system of calf-raising can be successfully applied under farm conditions.

b) That the rate of gain from birth through 26 weeks of age, as shown by this study, was comparable to other growth standards.

c) The estimated cost per pound of gain for calves of the Jersey and Holstein breeds was in agreement with results obtained at the Ohio Agricultural Experiment Station.

d) That the Ohio dairymen should be encouraged to use this system for reasons of economy.

e) That the calves raised on this system were comparable in appearance and condition to calves raised on other systems.

ACKNOWLEDGMENTS

Appreciation is gratefully extended to State and County Extension personnel and the selected dairymen who cooperated with the Ohio Agricultural Experiment Station workers to make this study possible. Especially we wish to thank the McMillen Feed Mills who supplied the high roughage pellets used in this demonstration.

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